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Technical Note

Design of a graticule indicating central axis position for use with portal imaging

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Abstract

This technical note describes a port film graticule that can be used to determine the central axis of a portal image when used with megavoltage film or on-line electronic portal imaging. The construction and quality control of the portal film graticule are highlighted.

Keywords

Graticule; portal image; construction; quality control

INTRODUCTION

Technological developments over recent years have ensured that 3D treatment planning and delivery has moved from a research concept to routine clinical practice in many radiotherapy departments.[1] The premise that improved dose conformation will decrease treatment morbidity and result in greater tumour control has prompted many dose escalation studies.[2,3] With the use of decreased treatment field sizes and increased dose regimes in 3D conformal radiotherapy, it is even more imperative that the treatment is delivered accurately and is reproducible on a day-to-day basis. Verification of treatment delivery in an attempt to quantify and possibly reduce patient set-up errors is therefore a current topic of interest.[4]

The introduction of conformal radiation treatment at this department followed the installation of an ADAC Pinnacle[3] 3D treatment planning system and prompted a review of treatment verification procedures.

Verification of treatment position in this centre has historically utilised a film/cassette system although increasing use of on-line electronic portal imaging is taking place as work practice protocols are developed. This article applies initially to the cross over period between megavoltage film use and electronic portal imaging.

The megavoltage film image is currently compared to the "gold standard" of the corresponding simulator image. In order to assess patient set up error, it is current protocol with megavoltage film to determine the central axis of the field on a double exposed image and then compare distances from prominent, stable bony landmarks to the defined central axis after appropriate demagnification. There is an inherent inaccuracy in this method in that the penumbra impedes the accuracy to which the beam edge and subsequent centre of the field can be determined. For a symmetric beam this has not proved to be a large problem but with increasing use of asymmetric

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fields with MLC shielding there is added subjectivity in accurately locating the central axis of the beam.

A marker was developed to provide accurate reference of field centre position on megavoltage port films taken in this department.

METHODS AND MATERIALS

Several requisites for the design of the marker were highlighted by a working party consisting of a treatment radiographer, planning radiographer, physicist and technician. These were:

- Accuracy.
- Reproducibility.
- Simplicity of use.
- No extra dose to patient.
- Minimal time required to position marker.
- Anatomical references not obliterated by the marker.

Material

Four materials were readily available in the department and were used as prototypes for the marker. The materials were lead, titanium, solder wire and tin. A portal film was taken during routine quality control checks on the megavoltage unit showing all four materials in an attempt to evaluate clarity and definition of resultant image. All members of the working party viewed the radiograph and concluded that the lead provided the clearest image with the most well-defined edge and, being readily available at no extra cost to the department, should be the material of choice.

Design

The initial design of the marker employed a small lead ball bearing placed manually on the patient's skin at the field centre, as determined by the cross-wire. The marker was held in place by tape. Portal images incorporating this design were taken of five different lateral isocentre checks for pelvic radiation treatments. It was found that the ball bearing did not consistently match the calculated position of the central axis. An extreme case on one image showed that the ball bearing was four millimetres off the calculated central axis position. The treatment radiographers suggested that the difficulty in placing a small marker onto the patient's skin may have contributed to this inaccuracy and so a more robust marker was designed. This consisted of a small lead cross-mounted in a Perspex disc to be placed on the patient's skin at the field centre as determined by the cross-wire. The Perspex disc was stated by the treatment radiographers to be useful when positioning the marker but proved to be inaccurate in field centre determination albeit by a smaller amount. The resultant image of the Perspex disc was also more imposing on the film than the smaller ball bearing. The working party concluded that inaccuracy of marker placement; patient movement or skin movement may have compromised the usefulness of these designs.

A third design therefore used the principle of a graticule that would be placed away from the patient in the head of the machine therefore avoiding positional inaccuracies as stated above. Two narrow channels were scored into a Perspex shielding tray insert at the position of the central axis. Two lengths of lead wire were compressed to form a 1×3 mm cross-section strip that was mounted in the channels. This was then assessed following a similar method to the previous two designs.

QUALITY CONTROL OF THE PORT FILM GRATICULE

Quality control of the port film graticule was initially carried out using the Varian simulator. The port film graticule was mounted in the shielding tray accessory holder (Fig. 1) and imaged together with the simulator graticule at gantry angles of 270°, 90° and 0°. The accuracy of the simulator graticule collimator rotation is within 0.5 mm. The superimposed image of both graticules showed the accuracy of port film graticule at the centre of the beam to be within one millimetre (Fig. 2). This procedure is now incorporated in the routine QA programme of the department and carried out at monthly intervals.

Subsequent images of the port film graticule taken during routine portal checks on five patients showed it to again be accurate to within one millimetre when correlating it to the manually determined field centre position on a symmetric field. Periodic assessment of ensuing portal films have continued to show the graticule design to be an

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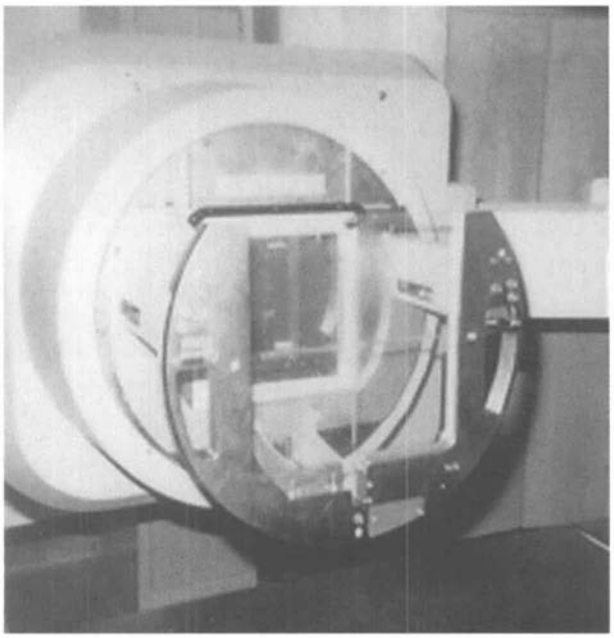
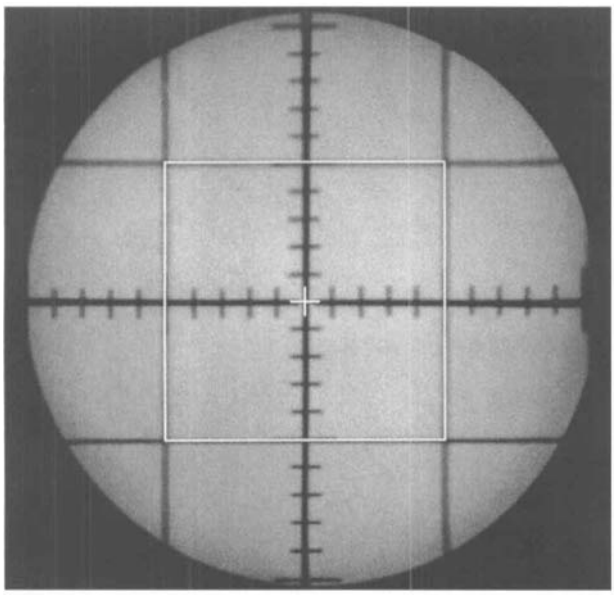


Figure 1. Quality control of portal film graticule using the simulator.



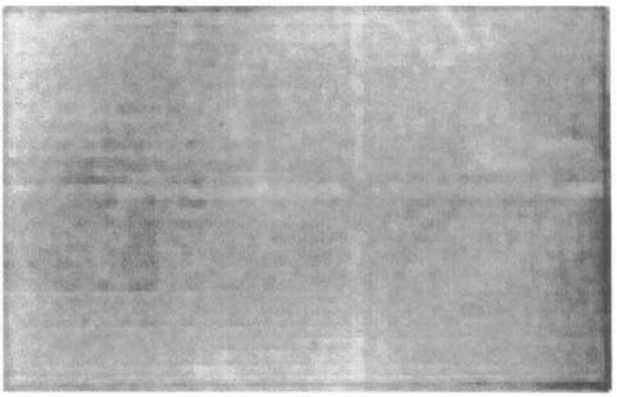
Scale Factor: 1.091

-SIMULATION FIELD-
Course ID : C1
Plan Setup ID : PS1
Field ID : G = 270, COLL = 90
Extension : 2
Field Name :
Simulation Date : 26/06/2002 10:16:08

-SIMULATION FIELD SETUP-
Scale : Ximatron IEC Mode 3
Gantry Rtn : 270.0 Collimator Rtn : 90.0
Coll. : X1 = 5.0 X2 = 5.0 Y1 = 5.0 Y2 = 5.0
Blade : X1 = – 12.0 X2 = 12.0 Y1 = – 10.3 Y2 = 10.3
Couch : Lat = 99.3 Lng = 116.7 Vrt = 22.7 Rtn = 0.2
SAD : 100.0
Image Int. : Lat = 0.0 Lng = 99.9 Vrt = 45.3

Figure 2. Comparison of field axis of treatment portal graticule against simulator graticule.

accurate marker for the central axis of the treatment field. Radiographers have suggested that analysis of portal radiographs is quicker and easier with the use of the graticule although no actual comparative study regarding speed and ease of analysis has been carried out.



Scale Factor: 1.201

-TREATMENT FIELD-
Course ID : C1
Plan Setup ID : PROSTATE
Field ID : RT LAT ISO CHECK
Field Name : RT LAT ISO CHECK

-TREATMENT FIELD SETUP-
WARNING: The field parameters are not verified
Scale : Varian IEC
Gantry Rtn : 270.1 Collimator Rtn : 90.0
Coll. : X1 = 4.6 X2 = 4.4 Y1 = 5.9 Y2 = 8.5
Couch : Lat = 0.9 Lng = 135.0 Vrt = 11.3 Rtn = 0.1
Energy Mode : 6X
Dose Rate : 80
Monitor Units : 6

Figure 3. Use of graticule with electronic portal imaging to show the treatment field axis in an asymmetric field (lateral iso check for a prostate plan).

CHANGE IN WORKING PRACTICE

The graticule was developed for use with the Varian linear accelerator and does not have an interlock system to acknowledge the presence of the graticule. A verbal check by the treatment radiographers is therefore necessary to confirm the presence of the graticule when undertaking a portal image procedure. The radiographers must also ensure removal of the graticule at the end of the image acquisition time. For a double exposure technique utilised for positional verification of radiation treatments employing shielding blocks, the graticule is used only on the large field exposure and replaced by the shielding blocks for the actual treatment parameter exposure. The graticule has been used both with multileaf collimators and the on-line electronic portal imaging device (Fig. 3).

CONCLUSION

The radiographers have found the portal film graticule to be a useful and reliable device in assessing the treatment field central axis on portal images for both symmetric and asymmetric treatment fields. It is simple and quick to use, and has proved reliable and accurate provided the quality assurance programme is adhered to.

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FUTURE DEVELOPMENTS

A modified graticule, at present under going quality control tests further develops the current design and utilises active Iridium[192] as the material of choice due to its availability within the department and its high density. Three pieces of 0.6 mm diameter iridium (from inactive hairpins) are mounted vertically above each other to form a cross at the central axes. Extra pieces are inserted along the axes at equidistant intervals from the central axis. This allows more anatomy on the image to be visualised with the added advantage of an inherent magnification scale. The original design material, lead, was discounted due to difficulties experienced in the manufacture of this modified graticule.

It is intended to incorporate the port film graticule into the on-line electronic imaging protocols that are superseding the film/cassette system.

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